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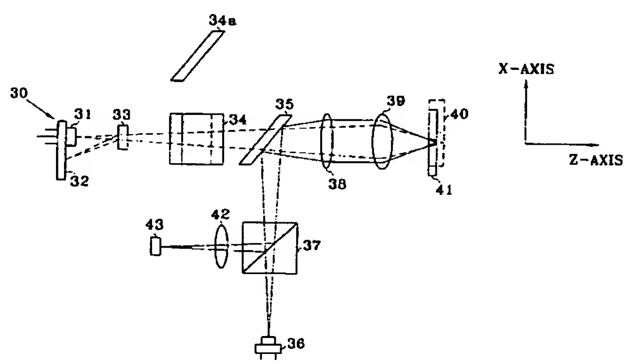
(54) Optical pickup compatible with recordable compact disk and digital video disk using plane parallel plates

(57) An optical pickup is compatible with at least two types of optical recording media which use light beams having different wavelengths for recording and reproduction of information. The optical pickup includes a first laser light source (31)for emitting a first light beam having a relatively long wavelength, and a second laser light source (36) for emitting a second light beam having a relatively short wavelength. A beam splitting plate (35) transmits the first light beam and reflects the second light beam toward a collimator (38) . The collimator (38) collimates the light beam incident from the beam splitting plate (35) to transmit the collimated light beam into an objective lens (39). The objective lens (39) is designed so that the second light beam is focused on the information recording surface of a second optical recording medium (41), whose information recording surface is closer to the objective lens (39), to form an optical spot optimized to the second optical recording medium (41). The optical distance from the first laser light source (31) to the information recording surface of a first optical recording medium (40) whose information recording surface is relatively farther from the objective lens (39), is shorter than the optical distance from the second laser light source (36) to the information recording surface of the second optical recording medium (41) so that spherical aberration occurring when the first light beam is used is removed. An aberration correction plate (34) is located in an optical path between the first laser light source (31) and the beam splitting plate (35), and corrects an optical aberration occurring when the beam splitting plate (35) is used.

FIG. 3



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Description

The present invention relates to an optical pickup compatible with a recordable compact disk (CD-R) and a digital video disk (DVD), and more particularly, to an optical pickup which can record and reproduce signals with respect to a DVD and a CD-R.

There are a disk, a card or a tape as a recording medium for recording and reproducing information such as video, audio or data at high density. Among them, a disk-shaped recording medium is mainly used. Recently, products in the field of optical disk device have been developed from laser disks (LDs) and compact disks (CDs) to DVDs. Such optical disks are comprised of a plastic or glass medium having a certain thickness for transmitting a beam of light incident from an optical pickup, and an information recording surface located on the medium and on which information is recorded.

A high-density optical disk system developed up to now enlarges a numerical aperture of an objective lens and uses a relatively short-wavelength light source of 635nm or 650nm, in order to heighten a recording density. As a result, the optical disk system can record and reproduce information with respect to a DVD and can also reproduce information recorded on a CD. The high-density optical disk system uses a light source outputting light whose wavelength is 780nm, in order to compatibly use a recordable compact disk (CD-R) (which is a recent type of a CD). This is due to a recording characteristic of a recording medium of the CD-R. It is essential for compatibility between a DVD and a CD-R to enable a single optical pickup to use both the light having a wavelength of 780nm and the light having a wavelength of 650nm. An existing optical pickup which is compatible with a DVD and a CD-R is described below with reference to Figure 1.

Figure 1 shows an optical pickup which uses a single objective lens, and two laser diodes as light sources for a DVD and a CD-R. The optical pickup shown in Figure 1 uses laser light with a wavelength of 635nm during reproduction with respect to a DVD, and uses laser light with a wavelength of 780nm during recording and reproduction with respect to a CD-R. The beam of light having a 635nm wavelength which is emitted from a light source 1, such as a laser diode, passes through a collimating lens 2 and a polarization beam splitter 3, and then proceeds to an interference filter prism 4. The beam of light having a 780nm wavelength which is emitted from a light source 11 (another laser diode) passes through a collimating lens 12 and a beam splitter 13, and then proceeds to a converging lens 14. The converging lens 14 makes the beam of light incident from the beam splitter 13 converged into the prism 4. An optical system having such a structure for converging the beam of light whose wavelength is 780nm is called a "finite optical system". The prism 4 transmits the 635nm wavelength light which is incident after being reflected by the polarization beam splitter 3, and reflects the light beam converged by the converging lens 14. As a result, the light emitted from the light source 1 is incident to a quarter-wave plate 5 in the form of a light beam made parallel by the collimating lens 2, and the light emitted from the light source 11 is incident to a quarter-wave plate 5 in the form of light beam diverged by the converging lens 14 and the prism 4. The light transmitted through the quarter-wave plate 5 is incident to an objective lens 7.

The objective lens 7 which is designed to be focused on an information recording surface of a DVD 8 having a thickness of 0.6mm, focuses the 634nm wavelength light beam emitted from the light source 1 on the information recording surface of the DVD 8. As a result, the light reflected from the information recording surface of the DVD 8 contains the information recorded on the information recording surface. The reflected light is transmitted through the polarization beam splitter 3 and is incident to an optical detector 10 for detecting optical information.

In the case that the above-described finite optical system is not employed, when the beam of the 780nm wavelength light emitted from the light source 11 is focused on the information recording surface of a CD-R 9 having a thickness of 1.2mm by using the objective lens 7, spherical aberration occurs due to a difference between the DVD 8 and the CD-R 9 in thickness. The spherical aberration is due to the fact that the information recording surface of the CD-R 9 is located at a farther place from the objective lens 7 than that of the DVD 8. To reduce the spherical aberration, the finite optical system constituted by using the converging lens 14 is required. By use of a variable aperture 6 to be described later with reference to Figure 2, the beam of the 780nm wavelength light is formed as an optical spot of an optimized size on the information recording surface of the CD-R 9. The beam of the 780nm wavelength light reflected from the CD-R 9 reflects from the prism 4, transmits through the converging lens 14, and reflects from the beam splitter 13, and then, is incident to a photodetector 15. The photodetector 15 detects information from the light incident from the beam splitter 13.

The variable aperture 6 shown in Figure 1 has a structure of a thin film which can selectively transmit the incident light, with respect to a region identical to a diameter of the objective lens 7, that is, a region having a numerical aperture (NA) not more than 0.6 shown in Figure 2. In other words, the optical surface of the variable aperture 6 is divided into a "region 1" which transmits both the 635nm wavelength light and the 780nm wavelength light and a "region 2" which totally transmits the 635nm wavelength light and totally reflects the 780nm wavelength light, on the basis of the centre of the optical surface. The region 1 is an area of the numerical aperture (NA) not more than 0.45. The region 2 is an outer area of the region 1 and is made by coating a dielectric thin film thereon. The region 1 is comprised of a quartz (SiO_2) thin film in order to remove optical aberration generated by the dielectric thin film coated region 2. Using

the variable aperture 6, the 780nm wavelength light which is transmitted through the region 1 of the numerical aperture (NA) not more than 0.45 is formed as an optical spot optimized to the information recording surface of the CD-R 9. Thus, the optical pickup of Figure 1 can record and pick up information with respect to a CD-R 9, even when a loaded disk is changed from the DVD 8 to the CD-R 9.

However, the above-described Figure 1 optical pickup should achieve a finite optical system with respect to the 780nm wavelength light, in order to remove the spherical aberration occurring due to compatibility between a DVD and a CD-R. Also, the dielectric thin film which is formed in the region 2 having the numerical aperture (NA) not less than 0.45 of the variable aperture 6, an optical path difference occurs between the light passed through the region 1 and the light passed through the region 2. To remove this optical path difference, the variable aperture 6 requires a particular optical thin film such as a quartz thin film formed on the region 1. For this reason, a quartz coating is formed on the region 1 and a multi-layered thin film is formed on the region 2, which causes a complicated manufacturing process. Also, the thickness of the thin film is adjusted on a μm scale, which does not fit mass-production.

With a view to solve or reduce the above problems, it is an aim of preferred embodiments of the present invention to provide an optical pickup which can be compatible with different types of optical recording media, using a beam splitting plate having a wavelength selective transmission characteristic with respect to the beams of light of different wavelengths and another plate which corrects an optical aberration occurring when the beam splitting plate is used.

According to a first aspect of the invention, there is provided an optical pickup which is compatible with at least two types of optical recording media, the optical pickup comprising: a first laser light source for emitting a first light beam having a relatively long wavelength; a second laser light source for emitting a second light beam having a relatively short wavelength; an objective lens for focusing the second light beam emitted from said second laser light source on the information recording surface of a second optical recording medium whose information recording surface is closer to the objective lens, to form an optical spot optimized to said second optical recording medium; a collimator for collimating a beam of light incident to transmit the collimated light beam to the objective lens; a beam splitting plate for transmitting a beam of light from one laser light source and reflecting a beam of light from the other laser light source, to transmit the beams of light to said collimator; and an aberration correction plate located on an optical path between the beam splitting plate and one of said first and second laser light sources, for correcting an optical aberration occurring when the beam splitting plate is used, wherein the optical distance from said first laser light source to the information recording surface of a first optical recording medium whose information recording surface is relatively farther from the objective lens, is shorter than the optical distance from said second laser light source to the information recording surface of said second optical recording medium, thereby removing a spherical aberration occurring when the first light beam is used.

Preferred embodiments of the first aspect may include the following features.

Preferably, said aberration correction plate is located on an optical path between said first laser light source and said beam splitting plate.

Said first laser light source and said objective lens are preferably aligned so that an optical axis of the direction proceeding from said first laser light source via the optical centre of the objective lens is coincident with a positive Z-axis direction in a rectangular coordinate system, said second laser light source and said beam splitting plate are aligned so that an optical axis of the direction proceeding from said second laser light source toward the optical centre of said beam splitting plate is parallel to a positive X-axis direction, the planes of said beam splitting plate are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive Y-axis, and, the planes of said aberration correction plate are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive X-axis.

Said aberration correction plate preferably has the same thickness as that of said beam splitting plate.

According to a second aspect of the invention, there is provided an optical pickup which is compatible with at least two types of optical recording media, the optical pickup comprising: a first laser light source for emitting a first light beam having a relatively long wavelength; a second laser light source for emitting a second light beam having a relatively short wavelength; an objective lens for focusing the second light beam emitted from said second laser light source on the information recording surface of a second optical recording medium whose information recording surface is located closer to the objective lens, to form an optical spot optimized to said second optical recording medium; a collimator for collimating a beam of light being incident to transmit the collimated light beam to the objective lens; a beam splitting plate for transmitting a beam of light from one laser light source and reflecting a beam of light from the other laser light source, to transmit the beams of light to said collimator; and an aberration correction plate for reflecting a light beam being incident from said beam splitting plate to transmit the reflected light beam into said collimator, and for correcting an optical aberration occurring when the beam splitting plate is used, wherein the optical distance from said first laser light source to the information recording surface of a first optical recording medium whose information recording surface is relatively farther from the objective lens, is shorter than the op-

tical distance from said second laser light source to the information recording surface of said second optical recording medium, thereby removing a spherical aberration occurring when the first light beam is used.

Preferred embodiments of the second aspect may include the following features.

Said first laser light source, said beam splitting plate and said aberration correction plate are preferably aligned so that an optical axis of the direction proceeding from said first laser light source via said beam splitting plate to said aberration correction plate is coincident with a positive Z-axis direction in a rectangular coordinate system, said second laser light source and said beam splitting plate are aligned so that an optical axis of the direction proceeding from said second laser light source toward the optical centre of said beam splitting plate is parallel to a positive X-axis direction, the planes of said beam splitting plate are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive X-axis, and, the planes of said aberration correction plate are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive Y-axis.

Said aberration correction plate preferably reflects the first light beam from the inner reflective surface reflects the second light beam from the surface thereof, and has half of the thickness of said beam splitting plate.

Preferred embodiments of the first and/or second embodiment may include any of the following features.

Said beam splitting plate may transmit the first light beam and reflect the second light beam.

Said beam splitting plate may have the form of a plane-parallel plate.

Said optical aberration corrected by said aberration correction plate is preferably astigmatism.

Said aberration correction plate may have the form of a plane-parallel plate.

The optical pickup may further comprise: beam splitter means for individually splitting the light proceeding toward said first and second laser light sources from the optical paths formed by the light emitted from said first and second laser light sources; and optical detectors for individually receiving the light splitted by said beam splitter means, wherein at least one of said optical detectors is made into a single unit together with a corresponding laser light source.

Preferably, said first optical recording medium is recordable compact disk (CD-R) and said second optical recording medium is digital video disk (DVD).

For a better understanding of the invention, and to show how embodiments of the same may be carried into effect, reference will now be made, by way of example, to the accompanying diagrammatic drawings, in which:

Figure 1 is a view showing an optical system of an optical pickup which is compatible with a DVD and a CD-R, which includes a single objective lens and two laser diodes as light sources for the DVD and CD-R;

Figure 2 is a view for explaining a variable aperture shown in Figure 1;

Figure 3 is a view showing an optical system of an optical pickup according to a preferred embodiment of the present invention;

Figure 4 is a view showing an optical system of an optical pickup according to another embodiment of the present invention; and

Figures 5A and 5B are views for explaining that astigmatism decreases by use of an aberration correction plate.

Preferred embodiments of the present invention will be described in detail with reference to the accompanying drawings.

Figure 3 is a view showing an optical system of an optical pickup which is compatible with a DVD and a CD-R according to a preferred embodiment of the present invention. The optical pickup shown in Figure 3 includes an optical unit 30 which is a single module being integrated with a laser light source 31 and an optical detector 32. The laser light source 31 emits first light whose wavelength is 780nm for recording and reproduction of signal with respect to a CD-R 40. A beam of the first light is shown as dotted lines in Figure 3. The optical detector 32 which detects the first light returning after being reflected from the information recording surface of the CD-R 40, receives the first light whose optical path is changed by a holographic beam splitter 33. A laser light source 36 emits second light whose wavelength is 650nm for recording and reproduction of a signal with respect to a DVD 41. The beam of the second light is shown as solid lines in Figure 3.

The optical pickup of Figure 3 also includes a beam splitting plate 35. The beam splitting plate 35 can make the optical pickup of Figure 3 wavelength-selectively use the first light of the 780nm wavelength and the second light of the 650nm wavelength. Therefore, the Figure 3 optical pickup uses two laser light sources 31 and 36, a beam splitting plate 35 and a single objective lens 39, to perform recording and pickup operations of signals with respect to a CD-R 40 and a DVD 41.

The beam splitting plate 35 is designed to have a form of plane-parallel plate and has a structure that an optical thin film is formed on the surface of a plate glass. For reference, the beam splitting plate 35 made of a plate glass costs less and is fabricated easily, accordingly, it is widely used for manufacture of an existing CD-dedicated optical pickup. As shown in Figure 3, the beam splitting plate 35 is located in an optical path between the laser light source 31 and a collimator 38 to be described later. For convenience of explanation, it is as-

sumed that an optical axis of the direction proceeding from the laser light source 31 via the optical centre of the objective lens 39 is coincident with a positive direction of Z-axis on a rectangular coordinate system and the Y-axis is parallel to the direction which perpendicularly protrudes from a surface of a drawing paper toward a viewer. The planes of the beam splitting plate 35 are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive Y-axis. The laser light source 36 is aligned so that the second light emitted from the laser light source 36 is reflected from the beam splitting plate 35 and then is incident to the objective lens 39. The beam splitting plate 35 has the optical characteristic that transmits the first light emitted from the laser light source 36. Thus, the second light reflected from the beam splitting plate 35 proceeds toward the objective lens 39.

A collimator 38 is located in an optical path between the beam splitting plate 35 and the objective lens 39. When the Figure 3 optical pickup uses the first light of the 780nm wavelength, the collimator 38 makes the beam of the first light incident from the beam splitting plate 35 substantially parallel with the optical axis of the objective lens 39. In reality, the beam of the first light passing between the collimator 38 and the objective lens 39 becomes a slightly diverging shape as shown in Figure 3. When the Figure 3 optical pickup uses the second light of the 650nm wavelength, the collimator 38 makes the second light incident from the beam splitting plate 35 perfectly parallel with the optical axis of the objective lens 39. The objective lens 39 to which the first light and the second light passing through the collimator 38 are incident is designed to accurately focus the second light of the 650nm wavelength emitted from the laser light source 36 on the information recording surface of the DVD 41. Therefore, the beam of the second light is formed as an optimized optical spot on the information recording surface of the DVD 41.

Meanwhile, when a loaded disk is changed from the DVD 41 into a CD-R 40, the first light of the 780nm wavelength is used, and consequently a spherical aberration occurs. As a result, the size of an optical spot formed on the information recording surface of the CD-R 40 by the first light becomes not less than 1.8μm. The size of an optical spot required for recording and pickup of signal with respect to the CD-R is generally about 1.4μm. Therefore, the Figure 3 optical pickup cannot record or pick up information with respect to the CD-R 40.

For this reason, the Figure 3 optical pickup is designed so that an optical distance from the laser light source 31 to the information recording surface of the CD-R 40 is shorter than that from the laser light source 36 to the information recording surface of the DVD 41. By doing so, the spherical aberration occurring when the first light is used is removed, with a result that the beam of the first light focused by the objective lens 39 is formed as an optimized optical spot on the information recording surface of the CD-R 40. Then, the size of the optical spot being formed on the information recording surface of the CD-R 40 becomes 1.4μm. Thus, the Figure 3 optical pickup can record and pick up information by using the first light with respect to the CD-R 40.

When the CD-R 40 is used, the first light reflected from the information recording surface of the CD-R 40 is transmitted through the objective lens 39 and incident to the collimator 38. The collimator 38 makes the beam of the first light incident from the objective lens 39 to be incident to the beam splitting plate 35 in the form of a convergent light beam. The beam splitting plate 35 transmits the first light convergently incident from the collimator 38. The first light transmitted through the beam splitting plate 35 proceeds toward the optical detector 32 of the optical unit 30 by the holographic beam splitter 33. Meanwhile, when the DVD 41 is used, the second light reflected from the information recording surface of the DVD 41 is transmitted through the objective lens 39 and the collimator 38 in sequence, and then is incident to the beam splitting plate 35. The beam splitting plate 35 reflects the second light incident from the collimator 38 toward a beam splitter 37. The beam splitter 37 reflects the second light incident from the beam splitting plate 35 and makes the reflected second light proceed toward a lens 42. The lens 42 which is located in an optical path between the beam splitter 37 and the optical detector 43, focuses the incident light on the optical detector 43.

However, in the optical pickup having the above-described optical structure, since the first light having the 780nm wavelength is transmitted through the beam splitting plate 35, astigmatism occurs. An aberration correction plate 34 is used to remove the astigmatism, which is located between the beam splitter 33 and the beam splitting plate 35. The aberration correction plate 34 is fabricated in the form of a plane-parallel plate, and the optical surfaces of the aberration correction plate 34 are aligned in parallel to the surface obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive X-axis. When a viewer views the drawing from the top to the bottom thereof, the aberration correction plate 34 appears to be an aberration correction plate 34a shown in the upper portion of the aberration correction plate 34. The aberration correction plate 34 has the same thickness as that of the beam splitting plate 35, so that astigmatism occurring when the first light passes through the beam splitting plate 35 is offset. Thus, the figure 3 optical pickup is compatible with the CD-R 40 and the DVD 41, using a single objective lens 39.

The beam splitting plate 35 can be modified to have optical characteristics of reflecting the first light of the 780nm wavelength and transmitting the second light of the 650nm wavelength. In this case, the laser light source 31 is installed in the position of the laser light source 36, and the laser light source 36 is installed in the position of the laser light source 31. Also the aber-

ration correction plate 34 has an optical characteristic of transmitting the second light of the 650nm wavelength.

Figure 4 is a view showing an optical system of an optical pickup according to another embodiment of the present invention. The optical pickup shown in Figure 4 includes a reflective aberration correction plate 44 which reflects both the first light of the 780nm wavelength and the second light of the 650nm wavelength, instead of the aberration correction plate 34 of Figure 3 transmitting the first light. The reflective aberration correction plate 44 is fabricated in the form of a plane-parallel plate and includes a first reflective platen 441 for reflecting the first light and a second reflective plane 443 for reflecting the second light. The first reflective plane 441 is formed by coating a total reflection material on the surface of a transparent plate glass and the like. The optical elements shown in Figure 4 have the same functions as those of the Figure 3 corresponding optical elements. However, since the Figure 4 optical pickup uses the reflective aberration correction plate 44, when the X-, Y- and Z-axes used in the description of the Figure 3 optical system are used as they are, the optical axis of the objective lens 39 becomes parallel with the X-axis. The collimator 38 is located on the optical path between the aberration correction plate 44 and the objective lens 39.

The optical surfaces of the beam splitting plate 45 shown in Figure 4 are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive X-axis. In other words, the optical surfaces of the beam splitting plate 45 are aligned in parallel with the optical surfaces of the aberration correction plate 34 as shown in Figure 3. The optical surfaces of the reflective aberration correction plate 44 are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centred around the Y-axis. The thus-aligned aberration correction plate 44 is for removing astigmatism as well, and has half of the thickness of the beam splitting plate 45. Therefore, the first reflective plane 441 of the aberration correction plate 44 removes astigmatism occurring due to the first light which is transmitted through the beam splitting plate 45.

Figures 5A and 5B show astigmatic field curves. Figure 5A shows astigmatism possessed by the optical system of the optical pickup of Figure 3 or 4 quantitatively, when the aberration correction plate 34 or 44 is not used. Figure 5B shows astigmatism possessed by the optical system of the optical pickup of Figure 3 or 4 quantitatively, when the aberration correction plate 34 or 44 is used. When using a rectangular coordinate system, in which a position on the information recording surface of the CD-R 40 which is located on the optical axis of the objective lens 39 is used as the origin of the rectangular coordinate system, X- and Y-axes are parallel with those of Figure 3 respectively, and Z-axis is parallel with the chief ray of the first light of the 780nm wavelength, the amount of the astigmatism, that is, an astigmatic difference, for the chief ray of the first light is represented as a distance between a position of a focal point on the X-axis and a position of the focal point on the Y-axis measured along the Z-axis. Here, the focal point position on the X-axis and the focal point position on the Y-axis are positions on the X- and Y-axes where focal lines formed by a chief ray of the first light locate. In Figures 5A and 5B, the horizontal axis denotes a distance from the origin to each of a focal point position on the X-axis and a focal point position on the Y-axis measured along the Z-axis, and the vertical axis denotes a degree that any chief ray of the first light being actually incident to the objective lens 39 is deviated from the optical axis of the objective lens 39. The angle of the optical axis of the objective lens 39 is defined as a zero degree.

As can be seen from the comparison between Figures 5A and 5B, when the aberration correction plate 34 or 44 according to the embodiments of the present invention is used, the astigmatism is remarkably reduced as shown in Figure 5B. The astigmatism characteristic shown in Figure 5B is substantially the same as that of a general lens. Therefore, optical pickups according to embodiments of the present invention have an amount of astigmatism within an allowable clearance and can be compatible with a DVD and a CD-R.

As described above, the optical pickup can record and pick up signals with respect to both a DVD and a CD-R, and can perform a pickup operation with respect to an existing CD as well. Further, the optical pickup can use a beam splitting plate which is fabricated in the form of a plate using a plate glass which is widely used in a relevant optical technological field, which causes an ultra-light and low-priced product to be manufactured. Also, an optical aberration occurring in a beam splitting plate is removed using an aberration correction plate fabricated in the form of a plate, which provides a more stable signal.

While only certain embodiments of the invention have been specifically described herein, it will be apparent that numerous modifications may be made thereto without departing from the scope of the invention.

The reader's attention is directed to all papers and documents which are filed concurrently with or previous to this specification in connection with this application and which are open to public inspection with this specification, and the contents of all such papers and documents are incorporated herein by reference.

All of the features disclosed in this specification (including any accompanying claims, abstract and drawings), and/or all of the steps of any method or process so disclosed, may be combined in any combination, except combinations where at least some of such features and/or steps are mutually exclusive.

Each feature disclosed in this specification (including any accompanying claims, abstract and drawings), may be replaced by alternative features serving the same, equivalent or similar purpose, unless expressly stated otherwise. Thus, unless expressly stated other-

wise, each feature disclosed is one example only of a generic series of equivalent or similar features.

The invention is not restricted to the details of the foregoing embodiment(s). The invention extends to any novel one, or any novel combination, of the features disclosed in this specification (including any accompanying claims, abstract and drawings), or to any novel one, or any novel combination, of the steps of any method or process so disclosed.

Claims

1. An optical pickup which is compatible with at least two types of optical recording media, the optical pickup comprising:

   a first laser light source (31) for emitting a first light beam having a relatively long wavelength;

   a second laser light source (36) for emitting a second light beam having a relatively short wavelength;

   an objective lens (39) for focusing the second light beam emitted from said second laser light source (36) on the information recording surface of a second optical recording medium (41) whose information recording surface is closer to the objective lens (39), to form an optical spot optimized to said second optical recording medium (41);

   a collimator (38) for collimating a beam of light incident to transmit the collimated light beam to the objective lens (39);

   a beam splitting plate (35) for transmitting a beam of light from one laser light source (31) and reflecting a beam of light from the other laser light source (36), to transmit the beams of light to said collimator (38); and

   an aberration correction plate (34) located on an optical path between the beam splitting plate (35) and one of said first and second laser light sources (31), for correcting an optical aberration occurring when the beam splitting plate (35) is used,

   wherein the optical distance from said first laser light source (31) to the information recording surface of a first optical recording medium (40) whose information recording surface is relatively farther from the objective lens (39), is shorter than the optical distance from said second laser light source (36) to the information recording surface of said second optical recording medium (41), thereby removing a spherical aberration occurring when the first light beam is used.

2. The optical pickup according to claim 1, wherein said aberration correction plate (34) is located on an optical path between said first laser light source (31) and said beam splitting plate (35).

3. The optical pickup according to claim 1 or 2, wherein said first laser light source (31) and said objective lens (39) are aligned so that an optical axis of the direction proceeding from said first laser light source (31) via the optical centre of the objective lens (39) is coincident with a positive Z-axis direction in a rectangular coordinate system,

   said second laser light source (36) and said beam splitting plate (35) are aligned so that an optical axis of the direction proceeding from said second laser light source (36) toward the optical centre of said beam splitting plate (35) is parallel to a positive X-axis direction,

   the planes of said beam splitting plate (35) are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive Y-axis, and,

   the planes of said aberration correction plate (34) are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive X-axis.

4. The optical pickup according to any of the preceding claims, wherein said aberration correction plate (34) has the same thickness as that of said beam splitting plate (35).

5. An optical pickup which is compatible with at least two types of optical recording media, the optical pickup comprising:

   a first laser light source (31) for emitting a first light beam having a relatively long wavelength;

   a second laser light source (36) for emitting a second light beam having a relatively short wavelength;

   an objective lens (39) for focusing the second light beam emitted from said second laser light source (36) on the information recording surface of a second optical recording medium (41) whose information recording surface is located closer to the objective lens (39), to form an optical spot optimized to said second optical re-

cording medium (41);

a collimator (38) for collimating a beam of light being incident to transmit the collimated light beam to the objective lens;

a beam splitting plate (45) for transmitting a beam of light from one laser light source (31) and reflecting a beam of light from the other laser light source (36), to transmit the beams of light to said collimator (38); and

an aberration correction plate (44) for reflecting a light beam being incident from said beam splitting plate (45) to transmit the reflected light beam into said collimator (38), and for correcting an optical aberration occurring when the beam splitting plate is used,

wherein the optical distance from said first laser light source (31) to the information recording surface of a first optical recording medium (40) whose information recording surface is relatively farther from the objective lens, is shorter than the optical distance from said second laser light source (36) to the information recording surface of said second optical recording medium (41), thereby removing a spherical aberration occurring when the first light beam is used.

6. The optical pickup according to claim 5, wherein said first laser light source (31), said beam splitting plate (45) and said aberration correction plate (44) are aligned so that an optical axis of the direction proceeding from said first laser light source (31) via said beam splitting plate (45) to said aberration correction plate (44) is coincident with a positive Z-axis direction in a rectangular coordinate system,

said second laser light source (36) and said beam splitting plate (44) are aligned so that an optical axis of the direction proceeding from said second laser light source (36) toward the optical centre of said beam splitting plate is parallel to a positive X-axis direction,

the planes of said beam splitting plate (45) are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive X-axis, and,

the planes of said aberration correction plate (44) are aligned in parallel to the plane obtained by rotating the XY-plane clockwise through an angle of 45 degrees centered around the positive Y-axis.

7. The optical pickup according to claim 5 or 6, wherein said aberration correction plate (44) reflects the first light beam from the inner reflective surface (441) reflects the second light beam from the surface (443) thereof, and has half of the thickness of said beam splitting plate (45).

8. The optical pickup according to any of the preceding claims, wherein said beam splitting plate (35, 45) transmits the first light beam and reflects the second light beam.

9. The optical pickup according to any of the preceding claims, wherein said beam splitting plate (35, 45) has a form of a plane-parallel plate.

10. The optical pickup according to any of the preceding claims, wherein said optical aberration corrected by said aberration correction plate (34, 44) is astigmatism.

11. The optical pickup according to any of the preceding claims, wherein said aberration correction plate (34, 44) has a form of a plane-parallel plate.

12. The optical pickup according to any of the preceding claims, further comprising:

beam splitter means (33, 37) for individually splitting the light proceeding toward said first and second laser light sources (31, 36) from the optical paths formed by the light emitted from said first and second laser light sources (31, 36); and

optical detectors (32, 43) for individually receiving the light splitted by said beam splitter means (33, 37),

wherein at least one of said optical detectors (32) is made into a single unit (30) together with a corresponding laser light source (31).

13. The optical pickup according to any of the preceding claims, wherein said first optical recording medium (40) is recordable compact disk (CD-R) and said second optical recording medium (41) is digital video disk (DVD).

FIG. 1 (PRIOR ART)

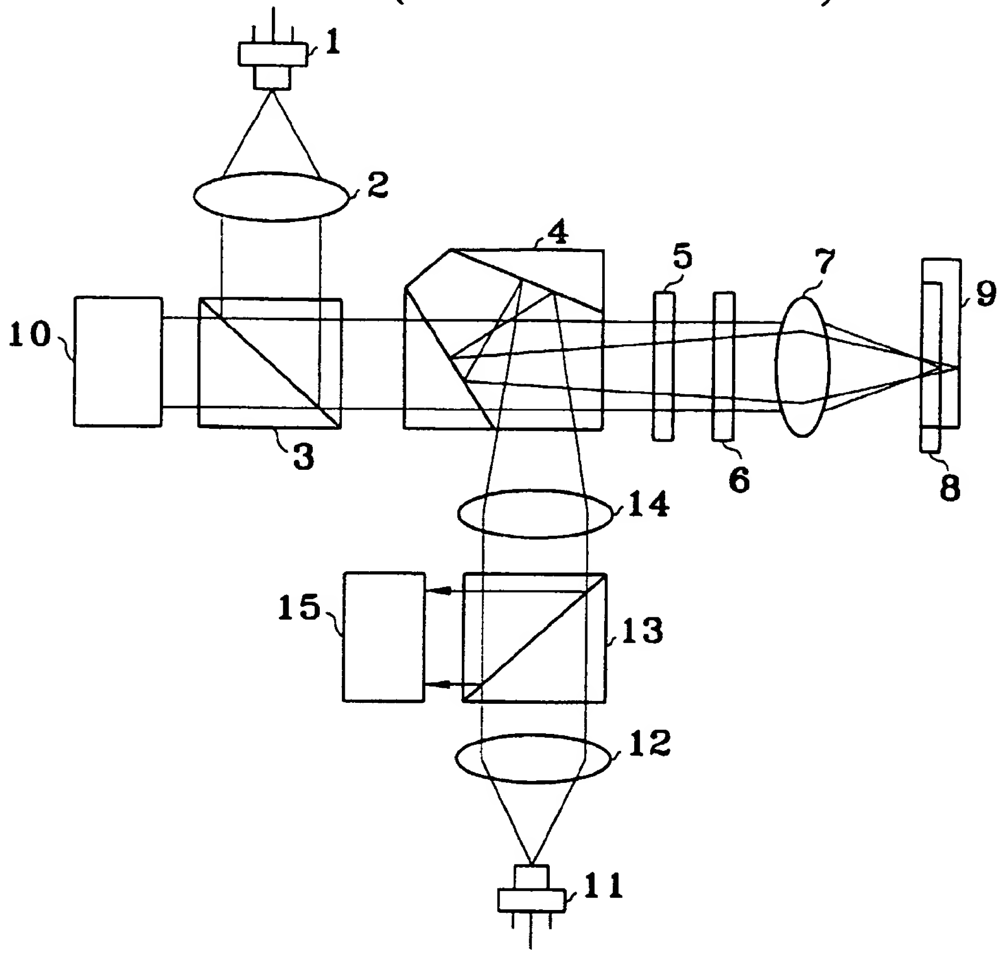


FIG. 2 (PRIOR ART)

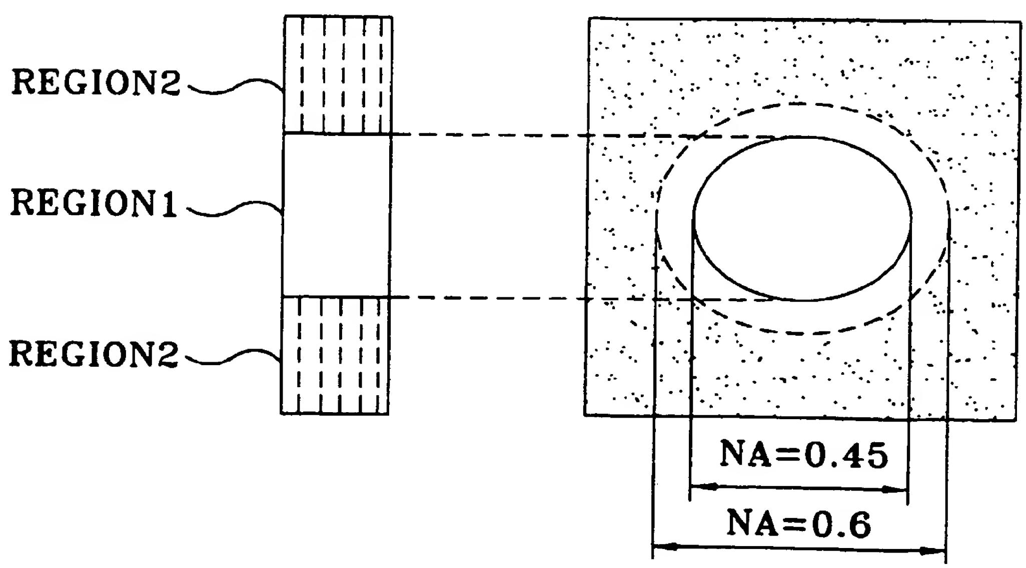


FIG. 3

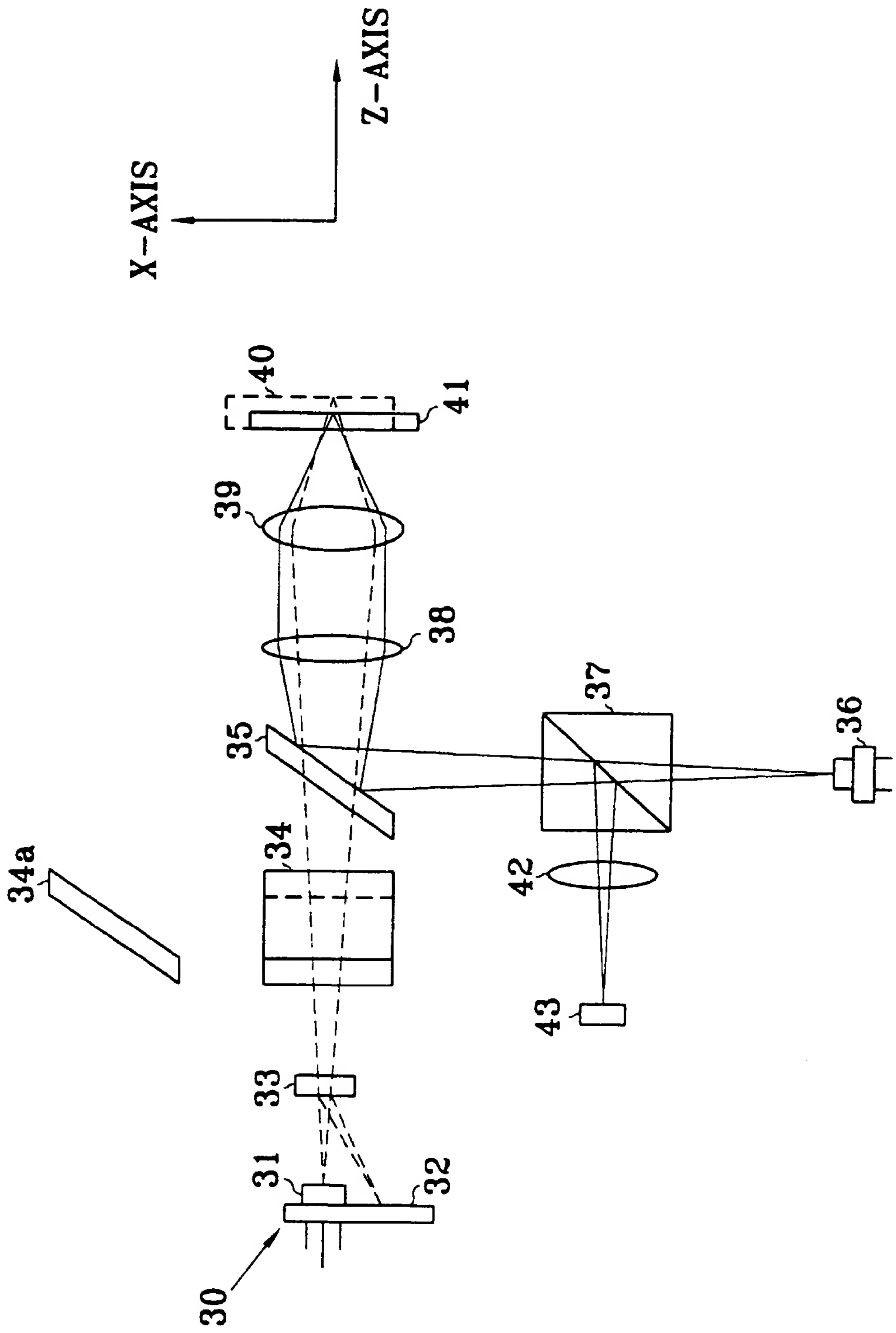


FIG. 4

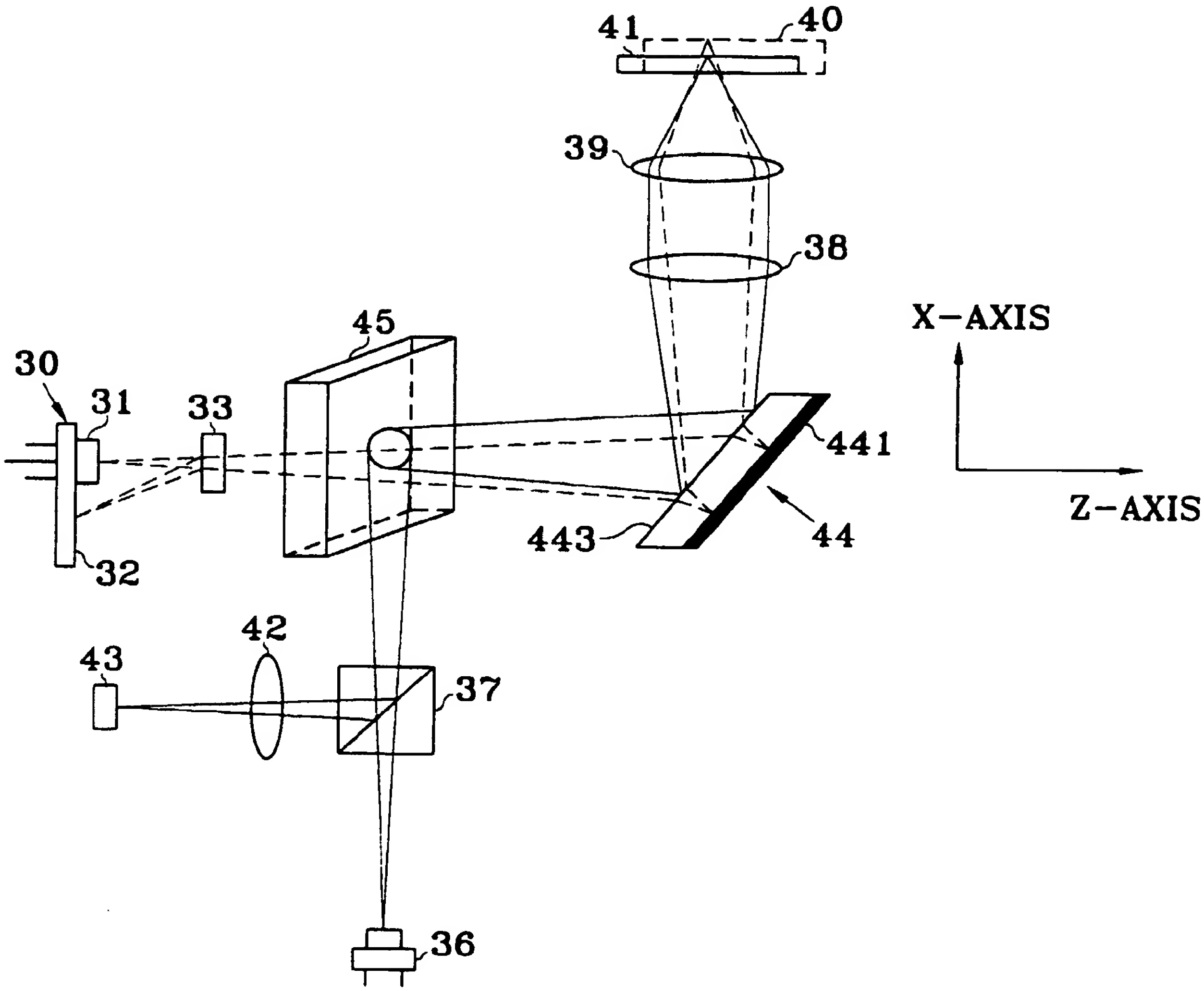
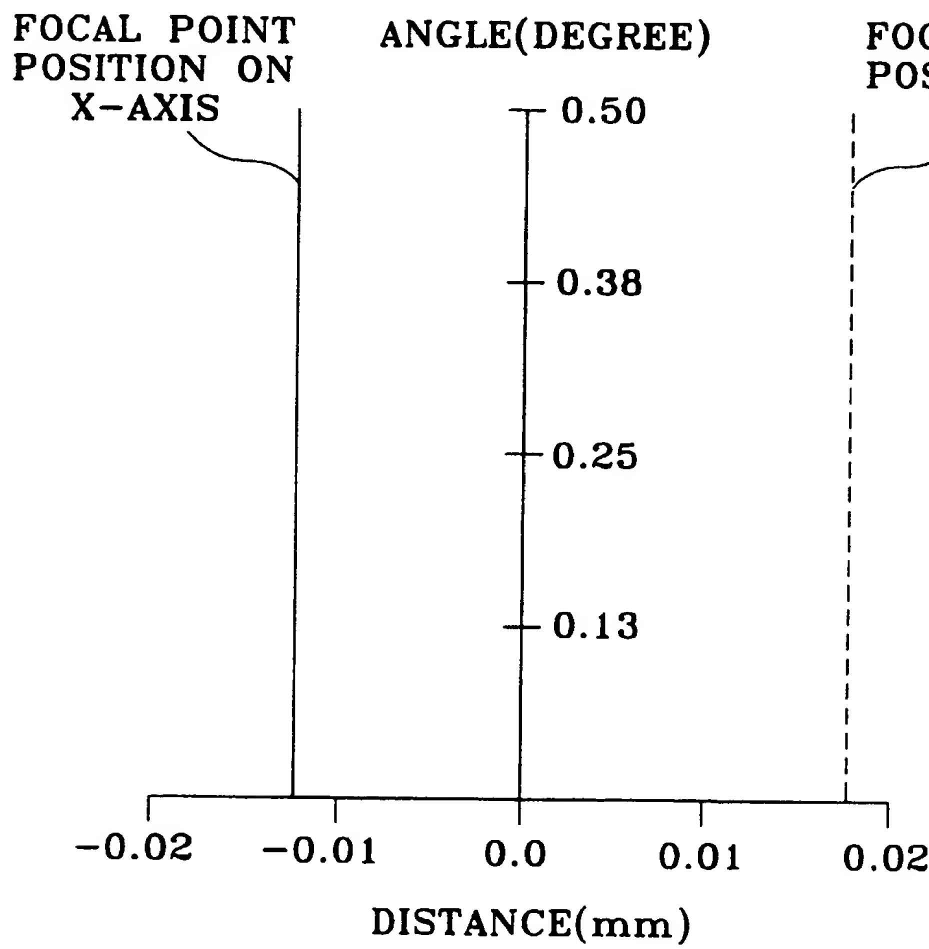


FIG. 5A


FOCAL POINT POSITION ON X-AXIS
ANGLE(DEGREE)
FOCAL POINT POSITION ON Y-AXIS
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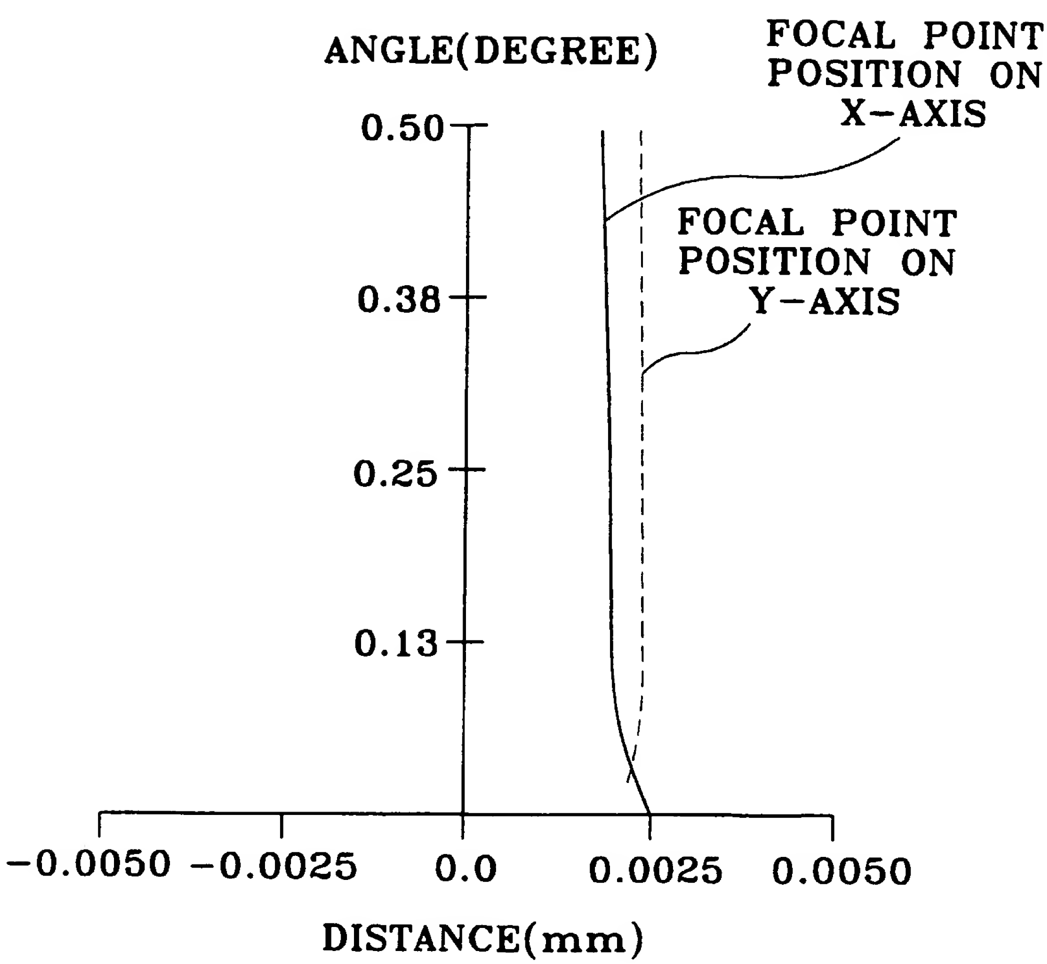
0.25
0.13
-0.02
-0.01
0.0
0.01
0.02
DISTANCE(mm)

FIG. 5 B


ANGLE(DEGREE)
FOCAL POINT POSITION ON X-AXIS
FOCAL POINT POSITION ON Y-AXIS
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0.38
0.25
0.13
-0.0050
-0.0025
0.0
0.0025
0.0050
DISTANCE(mm)

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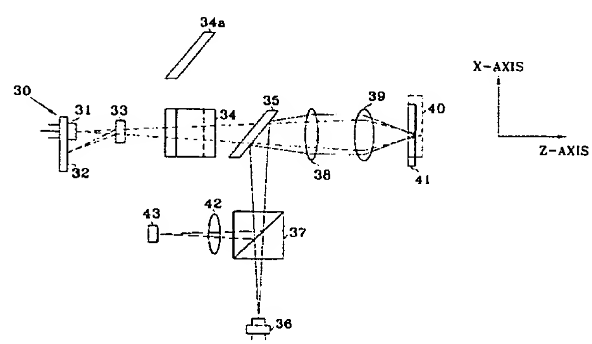
(54) **Optical pickup compatible with recordable compact disk and digital video disk using plane parallel plates**

(57) An optical pickup is compatible with at least two types of optical recording media which use light beams having different wavelengths for recording and reproduction of information. The optical pickup includes a first laser light source (31)for emitting a first light beam having a relatively long wavelength, and a second laser light source (36) for emitting a second light beam having a relatively short wavelength. A beam splitting plate (35) transmits the first light beam and reflects the second light beam toward a collimator (38) . The collimator (38) collimates the light beam incident from the beam splitting plate (35) to transmit the collimated light beam into an objective lens (39). The objective lens (39) is designed so that the second light beam is focused on the information recording surface of a second optical recording medium (41), whose information recording surface is closer to the objective lens (39), to form an optical spot optimized to the second optical recording medium (41). The optical distance from the first laser light source (31) to the information recording surface of a first optical recording medium (40) whose information recording surface is relatively farther from the objective lens (39), is shorter than the optical distance from the second laser light source (36) to the information recording surface of the second optical recording medium (41) so that spherical aberration occurring when the first light beam is used is removed. An aberration correction plate (34) is located in an optical path between the first laser light source (31) and the beam splitting plate (35), and corrects an optical aberration occurring when the beam splitting plate (35) is used.

FIG. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 98 30 0588

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
Y	PATENT ABSTRACTS OF JAPAN vol. 096, no. 006, 28 June 1996 & JP 08 055363 A (MATSUSHITA ELECTRIC IND CO LTD), 27 February 1996 * abstract * & US 5 703 856 A (HAYASHI HIDEKI ET AL) 30 December 1997 * column 15, line 66 - column 17, line 63 *	1,2,8,9, 12	G11B7/00 G11B7/135 G11B7/12
Y	US 5 303 221 A (MAEDA TAKANORI ET AL) 12 April 1994 * the whole document *	1,2,8,9, 12	
A	US 4 968 874 A (KASUGA IKUO) 6 November 1990 * the whole document *	8,9	
A	EP 0 747 893 A (NIPPON ELECTRIC CO) 11 December 1996 * page 4, line 47 - page 5, line 17; figure 5 *	1,5	
P,A	EP 0 803 867 A (NIPPON ELECTRIC CO) 29 October 1997 * column 10, line 27 - column 12, line 11; figure 5 *	1,5	

TECHNICAL FIELDS SEARCHED (Int.Cl.6)

G11B

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
MUNICH	11 November 1998	Moje, A

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